IP Addressing And Subnetting

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ICT Level 5

Introduction –

IP Addressing and Subnetting are fundamental concepts in computer networking. IP addressing is used to uniquely identify devices in a network, while subnetting is used to divide a large network into smaller networks (subnets) to improve performance, management, and security. These concepts are essential when designing, configuring, and troubleshooting computer networks. In modern networks, proper IP planning and subnetting help reduce network traffic and allow better control over network resources.

IP Address is,

An IP address (Internet Protocol address) is a unique numerical label assigned to each device connected to a network. It helps devices identify each other and communicate over a network.

Ex – 192.168.10.1

172.16.20.3

Types of IP addresses

01. By Function/Scope
   a. Public IP
      - A public IP address is used to identify a device on the internet. It is provided by the Internet Service Provider (ISP).
   b. Private IP
      - Private IP addresses are used inside local networks. These addresses are not routable on the internet.

Common private IP ranges:

1. 10.0.0.0 – 10.255.255.255
2. 172.16.0.0 – 172.31.255.255
3. 192.168.0.0 – 192.168.255.255

02. By Assignment
    a. Static IP
        • A permanent, unchanging address, good for hosting servers or remote access.
    b. Dynamic IP
        • Automatically assigned and changes, common for most consumer devices.

03. By Version
    a. IPV4 Address (internet protocol version 4)
        • Address size: 32-bit
        • Format: Decimal (e.g., 192.168.1.1)
        • Total addresses: 4,294,967,296
        • IPSec: Optional
        • Widely used but facing address exhaustion

    b. IPV6 Address (internet protocol version 6)
        • Address size: 128-bit
        • Format: Hexadecimal (e.g., 2001:db8::1)
        • Total addresses: 3.4×10^{38}
        • IPSec: Mandatory
        • Designed to solve IPv4 address shortage

IP Classes

01. Class A: Large networks, implemented by large companies and some countries. (1 - 128)
02. Class B: Medium-sized networks, implemented by universities. (129 - 191)
03. Class C: Small networks, implemented by ISP for customer subscriptions. (192 - 223)
04. Class D: Special use for multicasting. (224 - 239)
05. Class E: Used for experimental testing. (240 - 255)

IPv4 Subnet Mask-

There are three types of addresses within the address range of each IPv4 network.

1. Network address
2. Host addresses.
3. Broadcast address.

Network Address –

- The network address is a standard way to refer to a network. The subnet mask or the prefix length might also be used when referring to network address

Host Address –

- Every end device requires a unique address to communicate on the network. In IPv4 addresses, the values between the network address and the broadcast address can be assigned to end devices in a network.

Broadcast Address –

- The IPv4 broadcast address is a special address for each network that allows communication to all the hosts in that network. To send data to all hosts in a network at once, a host can send a single packet that is addressed to the broadcast address of the network, and each host in the network that receives this packet will process its contents

- The subnet mask is used to indicate the network and the host portion of an IP address.

The default subnet masks for three classes of IP addresses.

- 255.0.0.0 - Class A, which indicates that the first octet of the IPv4 address is the network portion.
- •255.255.0.0 - Class B, which indicates that the first two octets of the IPv4 address is the network portion.
- •255.255.255.0 - Class C, which indicates that the first three octets of the IPv4 address is the network portion.

Subnetting is

- Subnetting is the process of dividing a large network into smaller networks called subnets.
  Subnetting helps to:
  1. Reduce network traffic
  2. Improve network performance
  3. Increase security
  4. Use IP addresses efficiently

Subnet Mask and CIDR

- A subnet mask is used to identify the network portion and host portion of an IP address.
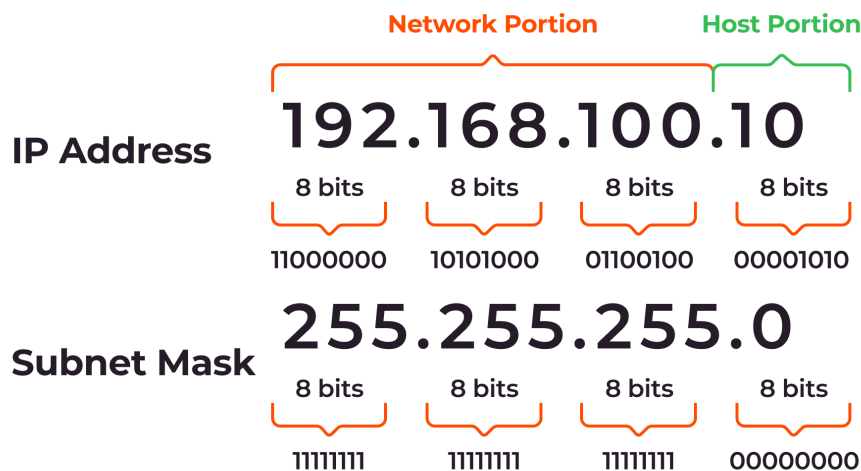
CIDR (Classless Inter-Domain Routing) is used to,

- allocate IP addresses more efficiently, alleviate IPv4 exhaustion, and reduce the size of internet routing tables by replacing rigid, class-based (A, B, C) addressing with flexible, variable-length subnet masking

  Ex- 192.168.15.63/24

  This means 24 bits are used for the network portion.

Binary Notation of IP Address and Subnet

	Network Portion			Host Portion
IP Address	192.	168.	100.	10
	8 bits	8 bits	8 bits	8 bits
	11000000	10101000	01100100	00001010
Subnet Mask	255.	255.	255.	0
	8 bits	8 bits	8 bits	8 bits
	11111111	11111111	11111111	00000000

Binary Explanation (IP Address in Binary Format)

- IP addresses are processed by computers in binary format (0s and 1s).
- An IPv4 address consists of 32 bits, divided into four octets (8 bits each).

Example:

IP Address: 192.168.1.10

Binary conversion:

192 = 11000000

168 = 10101000

1 = 00000001

10 = 00001010

So,

192.168.1.10 = 11000000.10101000.00000001.00001010

Importance of IPV4 Addresses

- Unique Device Identification: Every device on a network requires a unique IPv4 address (a 32-bit numerical label) to be identified, allowing data packets to be sent to the correct destination.
- Essential Data Routing: IPv4 addresses enable routers to direct data traffic efficiently, ensuring information reaches its destination with minimal delay.

Importance of Subnetting

- Improved Performance (Reduced Congestion)
- Enhanced Security
- Efficient IP Address Management
- Simplified Network Management & Troubleshooting
- Traffic Prioritization

Difference Between Classful and Classless Addressing (CIDR)

- Classful addressing is the older method of IP addressing that uses fixed classes (Class A, B, and C) with default subnet masks. This method often wastes many IP addresses and is not flexible.
- Classless addressing (CIDR) uses variable-length subnet masks (for example, /24, /26, /30), which allows more efficient and flexible allocation of IP addresses and reduces IP address wastage.

Conclusion

- This report covered the fundamentals of IP Addressing and Subnetting, including IPv4/IPv6, subnet masks, CIDR, and their importance in real-world networking. These concepts are essential for network design, configuration, and troubleshooting.